SPECIAL METHODS OF SEASONING WOOD

BOILING IN OILY LIQUIDS

Wood can be rapidly dried in an oily liquid maintained at a temperature high enough to boil off the water. A process using this method of drying as the first step in treating timbers with wood preservatives was patented by Curtis and Isaacs in 1895, and the idea probably was not entirely new then. A German patent was granted Zuhlsdorff in 1908. In its simplest form, the method has found limited use in drying cane blanks and small tool handles. In a modified process named after Boulton, water removal is speeded up by use of a vacuum. This process has been used extensively to condition, but not fully season, timber prior to preservative treatment. In recent years, some attempts have been made to commercialize the open-tank boiling-in-oil method, and other attempts have been made to develop closed-chamber processes with special solvents.

The process has numerous inherent drawbacks that have kept it from widespread use, except in the field of conditioning material for preservative treatment. Because of these limitations, the Forest Products Laboratory has not experimented extensively with it for the drying of lumber.

In the simple boiling-in-oil method, the wood is submerged in a water-repelling liquid, such as petroleum oil, creosote, or molten wax, which has a boiling point considerably above that of water. The liquid is gradually heated until the temperature of the bath is somewhat above the boiling point of water. Some of the water in the wood is turned into vapor or steam. The steam comes to the surface of the wood and boils off. As the water near the surface boils off, more vapor is formed in the wood and diffuses to the surface. While there is bulk water in the wood cells, the boiling is very rapid for easily dried woods, such as pine sapwood. The heat absorbed as the water vaporizes tends to keep the temperature of the wood near the boiling point of water. A thin film of nearly saturated water vapor protects the surface of the wood from the severe drying conditions of practically zero relative humidity in the oil itself. When the free water is gone from the cavities of the cells, the only water left is that contained in the cell walls. This water comes out more slowly than the free water. The outer protective vapor layer becomes very thin, and the surface becomes subject to the severe conditions of the heating oil.

If the diffusion of water from the inside of the wood to the surface is fast enough, checking may not occur. With woods that water does not readily diffuse through, such as sweetgum heartwood, the wood soon is unable to

† Maintained at Madison 5, Wisconsin in cooperation with the University of Wisconsin

provide enough water at the surface to protect itself from the severe drying conditions. The surface then begins to check. The high temperatures also tend to cause honeycombing in many woods.

Lumber dried by this boiling process retains severe casehardening stresses at the end of drying. These stresses result in warping when the lumber is resawn or machined, and also in other disadvantages. There is no way to relieve these stresses without giving the lumber a conditioning treatment in a kiln or other chamber equipped to control humidity and temperature conditions.

The wood in the bottom of a tank of heating oil may not dry so rapidly as the wood in the upper part of the tank because the hydrostatic pressure of the liquid tends to retard the escape of the water vapor. Uneven heating of the oil tends to cause uneven drying. Also, green wood has a wide variation in moisture content, and the boiling-in-oil process has no method of moisture equalization.

The following results were obtained in one commercial test of the simple boiling-in-oil process. One hundred and four 10- to 16-foot pieces of 4- by 8-inch green southern pine lumber were piled in an open steel tank. The timbers were piled on edge on a steel frame, with metal stickers between courses. Steam coils extended across the bottom and halfway up the sides of the tank. The load was fastened down, and enough oil was pumped in to cover the load. The temperature was raised to 260° F. in 1-1/2 hours and maintained at that level for 14-1/2 hours. Much of the water in the wood boiled off. At the end of the run, the oil was rapidly drained from the tank.

There was no general warping. End checking was prevalent in the heartwood and some of the sapwood. Mild to moderate surface checking was prevalent where heartwood was exposed on the sides of the timbers. Two of nine sample pieces had severe checking, and three had slight honeycombing. Casehardening was severe in all samples. The average moisture content had been reduced from 77 percent to 22 percent in 16 hours. Final moisture-content values ranged from 11 to 34 percent. The wood retained oil equivalent to 4.1 percent of the ovendry weight of the wood. Most of the oil was in the outer 1/8 inch. Rough calculations showed the oil retention to be about 12-1/4 gallons per thousand board feet. At 22 cents per gallon for the special oil used, the material retained cost $2.70 per thousand board feet.

Another commercial attempt to develop a successful boiling-in-oil process used underground storage tanks, an 8- by 24-foot drying cylinder, and an elaborate heating, piping, and pumping system. The process consisted of pumping the hot oil or solvent into and through the cylinder loaded with the lumber. Total filling, drying, and draining time was 6 hours for 1-inch and 8 hours for 2-inch Douglas-fir. The lumber appeared to be dry on the surface, but the center contained appreciable moisture. A week after completion of drying, tests showed 12 percent moisture content in the shell and 24 percent in the core. Both the residual stress and the moisture gradient were such as to cause cupping when the material was resawn.

A further variation of the simple boiling-in-oil process that commercial interests tried in small-scale tests involved spraying the oil over the wood. The tests did not give satisfactory results.

By carrying out the process in a closed cylinder and drawing a vacuum in the space over the oil, the water boils at a lower temperature. Below the moisture content at which the cell walls are saturated, however, the wood will not dry so fast as with the higher temperature because the drying rate will be a function of the rate of diffusion in the wood.

A more complicated variation of the boiling-in-oil method is called the McDonald process. A commercial dry-cleaning solvent, perchloroethylene, is used as the oily liquid. The wood is submerged in the fluid in a closed chamber. When the liquid is heated, a mixed vapor or azeotrope of water and the solvent boils off and is collected in a condenser. The liquids are not miscible, so they separate. The solvent is returned to storage or the drying chamber, while the water is drawn off as a liquid and can be measured. The azeotropic mixture has the advantages of boiling slightly below the boiling point of water and of retaining some water in the liquid, and thus appears to be less severe than the simple boiling-in-oil process. Results of a recent investigation to explore technical possibilities of combining the method into a drying and preservative-treating process have not been published.

Most of our woods will check under the very severe drying conditions of boiling-in-oil unless a vacuum is used. This is especially true of woods like oak, which check badly at high temperatures. The actual uses to which the process can be adapted and the best conditions to use would

have to be determined by experience. Consideration should be given to the fact that pervious woods that can be dried rapidly without checking by this method can also be dried rapidly by other means.

Many oily liquids suitable for drying wood by the boiling method are inflammable. Proper precautions should be taken to avoid sparks and open flames during their use. Gasoline and other materials with low flash points should be avoided entirely. A serious explosion and fire recently occurred in a lumber drying operation that used an oily liquid in a closed chamber. After the hot liquid had been drained, air was blown through the chamber to cool the lumber and remove the fumes. Apparently the fumes and the air, which was heated by the blowing operation or by the lumber itself, formed an explosive mixture. The fire spread to the oil storage tank. Fumes should be removed with wet steam or some inert gas, rather than air.

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